

RADIO NETWORK / BIDIRECTIONAL RADIO AMPLIFIER SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Bi-directional Radio Amplifier (BDA) System
- B. Installation and field testing.

1.02 MEASUREMENT AND PAYMENT

Separate measurement and payment will not be made for work required under this Section. All costs in connection with the work specified herein will be considered to be included with the related item of work in the Bid Schedule of the Bid Form, or incidental to the Work of this Contract.

1.03 REFERENCES

- A. Codes and Orders: The design of all equipment and materials shall conform to the following codes and orders:
 - 1. National Electrical Safety Code (NESC)
 - 2. California Electrical Code (CEC)
- B. Rules, Regulations and Plans:
 - 1. FCC Rules and Regulations 47 CFR.
 - 2. NPSPAC (National Public Safety Planning Advisory Committee) Requirements for 12.5 kHz off-set frequencies, Northern California Region 6 NPSPAC Plan.
- C. Standards: The following standards shall apply to the design work, and are hereby made a part of these Specifications to the extent referenced:
 - 1. Telecommunications Industry Association (TIA)
Technical Systems Bulletin TSB 88-A

1.04 SUBMITTALS

- A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data and Samples, for submittal requirements and procedures.
- B. Drawings: Submit detail drawings including panel and cabinet layouts, equipment interconnection diagrams, equipment and material lists, manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

- C. Instructions: Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, submit printed copies of these recommendations for approval prior to installation.
- D. Design: Submit design information as required for review and approval. If requested by the Engineer, a Design Review Meeting shall be held in a District facility for the Contractor to present the design submittal.

1.05 EXISTING TRUNKED RADIO SYSTEM DESCRIPTION

- A. The existing above ground trunked radio system is a 10 channel Enhanced Digital Access Communications System (EDACS™) simulcast system, as manufactured by M/A-Com.
- B. The radio system is designed to provide clear, intelligible communication from portable radios with area coverage reliability of 95% or better. In some locations, radio signal penetration into wayside facilities is insufficient to provide this level of communication performance. The provision of a Bi-directional Radio Amplifier (BDA) system within such a facility corrects for this condition.

PART 2 – PRODUCTS

2.01 GENERAL

- A. The BDA system shall be designed and furnished to operate in the 800 MHz band, specifically on 821-824 MHz /866-869 MHz. It shall be also capable of operation at 806-809 Mhz /851-853 Mhz, reaching these frequencies by readjustment only, without component change.
- B. The BDA system shall be designed to provide a minimum -90 dBm RF signal level, or a minimum of 10 dB above the RF noise floor, at any point within the building, or elsewhere as designated in the specifications or Contract Drawings.
- C. The BDA RF output shall not be close-coupled to the RF input so as to prevent feedback saturation. The minimum output-to-input path loss shall equal the maximum operating gain of the amplifier plus 10 dB. For example, a BDA with 55 dB overall maximum gain shall have minimum of 65dB input-to-output isolation. System component selection and layout shall take this requirement into consideration when placing the BDA system components in and around the building.
- D. The BDA system shall be capable of accurately and properly amplifying and distributing radio signals without causing any sort of radio system degradation. It shall be capable of using the following modulation techniques and formats:
 - 1. Analog FM
 - 2. Digital FM

3. EDACS™
 4. TDMA
 5. CDMA
 6. P25 Phase II
 7. GSM
- E. The BDA system shall be FCC type-accepted, and labeled as such prior to placing it into operation.

2.02 BI-DIRECTIONAL AMPLIFIER

- A. The BDA shall be an automatic gain adjusting or OLC (output level control) type, where the gain is automatically set over a wide operating range. The BDA system shall be FCC type accepted, and labeled as such prior to placing it into operation.
- B. An input signal level of -60 dBm is the nominal input signal level applied into the BDA system. The Contractor shall take steps to augment local input signal reception to this level. Less input signal might cause the BDA system to operate at a reduced output signal level. If the Contractor cannot make the input level reach the nominal level, the Contractor shall notify the Engineer, and provide the expected input signal level, and corresponding output level as part of the design submittal.
- C. The BDA system shall amplify all signals within the specified frequency band. The effective output power per channel is reduced as more channels are amplified. The Contractor must account for the reduction in signal strength when calculating the signal distribution within the building. The following table depicts the typical effect of multiple channel amplification.

Number Of Frequencies In The Passband	Maximum Output Power Per Single Channel
2	24.7 dBm
4	20.0 dBm
6	17.5 dBm
8	15.5 dBm
10	14.1 dBm
20	9.8 dBm

- D. The maximum output power of the amplifier shall be set below the amplifier's 1 dB compression point to prevent damage to the amplifier and minimize signal distortion. If necessary, external attenuator pads shall be inserted before the electronic attenuator to prevent overdriving the BDA OLC circuitry.

- E. Decoupled RF test points shall be provided to permit performance testing or alignment while the BDA is in operation. They shall be clearly labeled as test points, and depicted on a block diagram with the rest of the BDA circuitry.
- F. The BDA system shall be powered by the building's electrical distribution system. A transient voltage surge suppressor shall be provided as part of the bidirectional amplifier design, and protect the incoming power line from transients.
- G. If shown on the Contract Drawings, a backup electrical power supply shall be provided for the BDA system. It shall be designed to permit a minimum of four hours of BDA operation. If a battery supply is used as backup, a power supply shall be furnished to maintain the batteries at the manufacturer's recommended float level and shall also recharge the batteries should the charge be depleted. Alternatively, the backup power may be provided from an existing building UPS and/or generator system.
- H. The BDA unit shall be furnished in a wall mounted NEMA 4 cabinet. The cabinet shall have a front door that is provided with either a locking handle or lock hasp. Adequate space inside the cabinet shall be provided for servicing the unit. The unit shall be labeled with an exterior nameplate stating "Radio Amplifier". Internal components shall be identified with labels.
- I. If installed outdoors or unprotected locations, the cabinet shall be weatherproof stainless steel NEMA 4. All penetrations into the cabinet shall be made with RGS or IMC conduit, and weatherproofed.

2.03 EXTERIOR ANTENNA SYSTEM

- A. The exterior antenna system shall consist of a highly directional gain antenna, an antenna mount, coaxial lightning surge suppressor, and a minimum 1/2" type LDF coaxial cable feed to the BDA. The specific size of the feed line coaxial cable shall depend on the system design. A short super flexible cable may be used to connect the antenna to the RF feed line cable. The exterior antenna shall be configured to mount on or near the building rooftop, at a location affording the best view towards the nearest radio repeater site. The antenna shall be oriented towards the nearest system repeater site. If requested, the District will provide the antenna orientation. The antenna gain shall be selected to provide the minimum required signal level.
- B. A lightning surge suppressor shall be connected in the RF coaxial feed line in-between the antenna and the BDA. The coaxial lightning surge suppressor shall be Polyphaser Model IS-50NX-C2 or equal, 50 ohm, N-Female termination, flange mounted. A copper grounding plate shall be provided with the surge suppressor, and bonded to the grounding system. If the BDA is mounted inside a building, the surge suppressor will be installed inside that building at the cable penetration point. Building penetration for RF feed line cabling shall be protected with a waterproof/UV stabilized cable boot suitable for the installation, or with an electrical service weatherhead and coaxial cable drip loop.
- C. The antenna system, antenna mast, coaxial cable, and surge suppressor shall be grounded by attachment to the building's grounding system. If necessary, a new ground rod shall be driven to provide a grounding path for the antenna system to

earth. The coaxial cable shall be connected to the ground system by means of the cable manufacturer's shield grounding kit. A Ground system connection to the coaxial cable shall be at either end of exterior-run coaxial cable if it exceeds 100 feet in length, otherwise within 20 feet of building entrance. The coaxial lightning surge suppressor shall be grounded per the manufacturer's recommendations. Grounding cable shall be sized according manufacturer's recommendations.

- D. The antenna installation shall be suitable for operation with wind loading of 80 mph in no ice conditions. All components shall be suitable for outdoor installation. All outdoor RF connections and coaxial cable grounding kits shall be covered in weatherproof connector boot coverings.

2.04 IN-BUILDING ANTENNA SYSTEM

- A. The in-building antenna system shall consist of a sufficient number of antennas and/or radiating cable distributed within the building to meet the -90 dBm, or 10 dB above noise floor, design criteria throughout the building. Coaxial power dividers shall distribute and balance the radio signals into appropriate branch circuits connecting back to the BDA. A RF link budget shall be developed and submitted as part of the design submittal to show the distribution of signals throughout the cabling system.
- B. The coaxial cable shall be a minimum of ½" type foam dielectric low loss type and shall be installed as depicted in the Contract Drawings. Radiating coaxial cable shall be minimum of 7/8" foam dielectric, and shall be installed a minimum of 2 inches off of any wall surface. Cable jackets for any coaxial cables installed indoors shall be low smoke, non-halogen construction. Attachment between the cable and building shall be by plastic cable clamps, expressly designed for the application.
- C. Each splitter shall be mounted in a separate junction box located so as to be easily accessible for maintenance while maintaining security from unauthorized tampering. Each junction box shall be labeled externally.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The BDA and backup electric power housing shall be wall mounted side by side. The equipment room where the BDA is mounted must have access to the building halo or electrical ground system and shall be well ventilated. Maximum ambient temperature of the mounting location shall be 30°Ct. An electric circuit breaker panel with two, 120 VAC, 20 amp branch circuits shall be installed in the equipment room to service the BDA unit and backup power supply. All exterior coaxial cable shall be installed in 2-inch conduit.
- B. If RF distribution requires, a junction box shall be installed in the equipment room and every two floors below the equipment room with a box terminating in the lowest level of the building. The roof end of the conduit must extend two feet above the roof deck and be terminated with an electrical wire head.

3.02 SYSTEM OPTIMIZATION

- A. The BDA shall be adjusted to the level of desired signal and avoid inter-modulation. Fixed attenuators may be used to set the BDA levels if required.
- B. The BDA's OLC circuits shall provide a dynamic range of 30 to 40 dB. If the input level to the BDA causes continual output limiting, a fixed value coaxial RF attenuator shall be inserted at a point provided in the BDA's input circuit.

3.03 FIELD TESTING

- A. Perform all work necessary to plan, schedule, and conduct tests, and to complete the required documentation as specified in the Contract.
- B. Verify that the BDA system has been installed in accordance with these specifications, the Contract Drawings and the system performance criteria. This includes inspection, test and measurements of the D.C. power, the BDA gain, and the signal levels within and outside of the building. Record all test measurements. Provide diagrams showing equipment placement and routing for antennas, coaxial cables and AC power to the District's Representative prior to acceptance testing. Submit an RF Compliance Certificate for each BDA system at the conclusion of the acceptance testing.

END OF SECTION 33 83 06